

WHAT IS CLAIMED IS:

1. A phase shifter film used for a phase shift mask, characterized in that said phase shifter film is a film formed by using a reactive long throw sputtering device.

2. The phase shifter film according to Claim 1, characterized in that said reactive long throw sputtering device separately introduces a reactive gas and an inert gas, respectively.

3. The phase shifter film according to Claim 2, characterized in that said reactive gas is introduced into the substrate side and said inert gas is introduced into the target side.

4. The phase shifter film according to Claim 2, characterized in that, in said reactive long throw sputtering device:

the pressure is 7.5×10^{-4} Torr or less;

the distance between said target and said substrate is 100mm or

5 more;

the flow amount ratio of said reactive gas to said inert gas is $50\% \leq$ reactive gas/inert gas $\leq 80\%$.

5. The phase shifter film according to Claim 1, characterized in that said reactive long throw sputtering device mixes reactive gases and inert gases, respectively, so as to be introduced.

6. The phase shifter film according to Claim 1, wherein a heat treatment of 200 degrees(°C) or more is carried out on said phase shifter film.

7. The phase shifter film according to Claim 1, wherein said phase shifter film is made of a molybdenum silicide oxide nitride.

8. A process for a phase shifter film used for a phase shift mask, characterized in that said phase shifter film is formed by using a reactive long throw sputtering method.

9. The process for a phase shifter film according to Claim 8, characterized in that said reactive long throw sputtering method separately introduces a reactive gas and an inert gas, respectively.

10. The process for a phase shifter film according to Claim 9, characterized in that said reactive gas is introduced into the substrate side and said inert gas is introduced into the target side.

11. The process for a phase shifter film according to Claim 9, characterized in that, in said reactive long throw sputtering method:

the pressure is 7.5×10^{-4} Torr or less;

5 the distance between said target and said substrate is 100mm or more;

the flow amount ratio of said reactive gas to said inert gas is $50\% \leq \text{reactive gas/inert gas} \leq 80\%$.

12. The process for a phase shifter film according to Claim 8, characterized in that said reactive long throw sputtering device mixes reactive gases and inert gases, respectively, so as to be introduced.

13. The process for a phase shifter film according to Claim 8, wherein said step of forming a phase shifter film further includes the step of carrying out a heat processing of 200 degrees(°C) or more after forming said phase shifter film.

14. The process for a phase shifter film according to Claim 8, wherein said phase shifter film is made of a molybdenum silicide oxide nitride.

15. Blanks for a phase shift mask including a transparent substrate and a phase shifter film provided on this transparent substrate, characterized in that said phase shifter film is a film formed by using a reactive long throw sputtering device.

16. Blanks for a phase shift mask according to Claim 15, characterized in that said reactive long throw sputtering device separately introduces a reactive gas and an inert gas, respectively.

17. Blanks for a phase shift mask according to Claim 16, characterized in that said reactive gas is introduced into the substrate side and said inert gas is introduced into the target side.

18. Blanks for a phase shift mask according to Claim 16, characterized in that, in said reactive long throw sputtering device:

the pressure is 7.5×10^{-4} Torr or less;

the distance between said target and said substrate is 100mm or

5 more;

the flow amount ratio of said reactive gas to said inert gas is $50\% \leq$ reactive gas/inert gas $\leq 80\%$.

19. Blanks for a phase shift mask according to Claim 15, characterized in that said reactive long throw sputtering device mixes reactive gases and inert gases, respectively, so as to be introduced.

20. Blanks for a phase shift mask according to Claim 15, wherein a heat treatment of 200 degrees ($^{\circ}\text{C}$) or more is carried out on said phase shifter film.

21. Blanks for a phase shift mask according to Claim 15, wherein said phase shifter film is made of a molybdenum silicide oxide nitride.

22. Blanks for a phase shift mask according to Claim 15, further

including a metal film on said phase shifter film.

23. Blanks for a phase shift mask according to Claim 22, wherein said metal film is a film made of any materials among molybdenum, chromium, tungsten, tantalum, titanium, silicon or aluminum or is an alloy film made of any combination of these.

24. Blanks for a phase shift mask according to Claim 15, wherein said blanks for a phase shift mask further include a resist film on said transparent substrate.

25. Blanks for a phase shift mask according to Claim 15, further including a resist film on said phase shifter film and a static charge prevention film on said resist film.

26. Blanks for a phase shift mask according to Claim 25, wherein said static charge prevention film is made of a conductive polymer material.

27. A process for blanks for a phase shift mask having the step of forming a phase shifter film on a transparent substrate, characterized in that, in said step of forming a phase shifter film, a phase shifter film is formed by using a reactive long throw sputtering method.

28. The process for blanks for a phase shift mask according to Claim 27, characterized in that said reactive long throw sputtering method separately introduces a reactive gas and an inert gas, respectively.

29. The process for blanks for a phase shift mask according to Claim 28, characterized in that said reactive gas is introduced into the substrate side and said inert gas is introduced into the target side.

30. The process for blanks for a phase shift mask according to Claim 28, characterized in that, in said reactive long throw sputtering

method:

- 5 the pressure is 7.5×10^{-4} Torr or less;
 the distance between said target and said substrate is 100mm or more;
 the flow amount ratio of said reactive gas to said inert gas is $50\% \leq$ reactive gas/inert gas $\leq 80\%$.

31. The process for blanks for a phase shift mask according to Claim 27, characterized in that said reactive long throw sputtering device mixes reactive gases and inert gases, respectively, so as to be introduced.

32. The process for blanks for a phase shift mask according to Claim 27, wherein said step of formed blanks for a phase shift mask includes the step of carrying out a heat processing of 200 degrees(°C) or more after forming said phase shifter film by using a sputtering method.

33. The process for blanks for a phase shift mask according to Claim 27, wherein said phase shifter film is made of a molybdenum silicide oxide nitride.

34. The process for blanks for a phase shift mask according to Claim 27, further including the step of forming a metal film after said step of forming a phase shifter film.

35. The process for blanks for a phase shift mask according to Claim 34, wherein said metal film is a film made of any materials among molybdenum, chromium, tungsten, tantalum, titanium, silicon or aluminum or is an alloy film made of any combination of these.

36. The process for blanks for a phase shift mask according to Claim 27, further including the step of forming a resist film after said step of forming a phase shifter film and the step of forming a static charge prevention film on said resist film after forming said resist film.

37. The process for blanks for a phase shift mask according to Claim 36, wherein said static charge prevention film is made of a conductive polymer material.

38. A phase shift mask including a transparent substrate and a phase shifter film which is provided on this transparent substrate and which has a predetermined exposure pattern, characterized in that said phase shifter film is a film formed by using a reactive long throw sputtering device.
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39. The phase shift mask according to Claim 38, characterized in that said reactive long throw sputtering device separately introduces a reactive gas and an inert gas, respectively.

40. The phase shift mask according to Claim 39, characterized in that said reactive gas is introduced into the substrate side and said inert gas is introduced into the target side.

41. The phase shift mask according to Claim 39, characterized in that, in said reactive long throw sputtering device:
the pressure is 7.5×10^{-4} Torr or less;
the distance between said target and said substrate is 100mm or
5 more;
the flow amount ratio of said reactive gas to said inert gas is $50\% \leq$ reactive gas/inert gas $\leq 80\%$.

42. The phase shift mask according to Claim 38, characterized in that said reactive long throw sputtering device mixes reactive gases and inert gases, respectively, so as to be introduced.

43. The phase shift mask according to Claim 38, wherein a heat treatment of 200 degrees($^{\circ}$ C) or more is carried out on said phase shifter

film.

44. The phase shift mask according to Claim 38, wherein said phase shifter film is made of a molybdenum silicide oxide nitride.

5 45. A process for a phase shift mask including the step of forming a phase shifter film on a transparent substrate, the step of forming a resist film which has a predetermined pattern on said phase shifter film and the step of patterning said phase shifter film by using said resist film as a mask, characterized in that said step of forming a phase shifter film has the step of forming a phase shifter film by using a reactive long throw sputtering method.

46. The process for a phase shift mask according to Claim 45, characterized in that said reactive long throw sputtering device separately introduces a reactive gas and an inert gas, respectively.

47. The process for a phase shift mask according to Claim 46, characterized in that said reactive gas is introduced into the substrate side and said inert gas is introduced into the target side.

48. The process for a phase shift mask according to Claim 46, characterized in that, in said reactive long throw sputtering method:
the pressure is 7.5×10^{-4} Torr or less;
the distance between said target and said substrate is 100mm or
5 more;
the flow amount ratio of said reactive gas to said inert gas is $50\% \leq$
reactive gas/inert gas $\leq 80\%$.

49. The process for a phase shift mask according to Claim 45, characterized in that said reactive long throw sputtering method mixes reactive gases and inert gases, respectively, so as to be introduced.

50. The process for a phase shift mask according to Claim 45, wherein said step of forming a phase shifter film includes the step of carrying out a heat treatment of 200 degrees(°C) or more after forming said phase shifter film.

51. The process for a phase shift mask according to Claim 45, wherein said phase shifter film is made of a molybdenum silicide oxide nitride.

52. The process for a phase shift mask according to Claim 51, further including the step of forming a metal film between said step of forming a phase shifter film and said step of forming a resist film.

53. The process for a phase shift mask according to Claim 51, wherein said metal film is a film made of any materials among molybdenum, chromium, tungsten, tantalum, titanium, silicon or aluminum or is an alloy film made of any combination of these.

54. The process for a phase shift mask according to Claim 52, wherein said step of patterning the phase shifter film includes the step carried out by a dry etching method using a mixture gas of fluorocarbon and oxygen.

55. The process for a phase shift mask according to Claim 45, further including the step of forming a static charge prevention film on said resist film after the step of forming said resist film.

56. The process for a phase shift mask according to Claim 55, wherein said static charge prevention film is made of a conductive polymer material.

57. The process for a phase shift mask according to Claim 55, wherein said static charge prevention film is made of a molybdenum based

metal material.

58. The process for a phase shift mask according to Claim 55, wherein the step of forming said resist film which has a predetermined pattern includes:

- the step of exposing said resist film;
- 5 the step of removing said static charge prevention film before developing said resist film; and
- the step of developing said resist film.

59. The process for a phase shift mask according to Claim 58, characterized in that, in said step of removing the static charge prevention film, said static charge prevention film is removed by using water.

60. An exposure method using a phase shift mask which has the step of applying a resist film on a pattern formation layer and of exposing said resist film by using a phase shift mask including a predetermined pattern, characterized in that said phase shift mask includes a transparent
- 5 substrate and a phase shifter film which is provided on this transparent substrate and which has a predetermined exposure pattern and in that said phase shifter film is a film formed by using a reactive long throw sputtering device.

61. A semiconductor device manufactured by using a phase shift mask, characterized in that said phase shift mask includes a transparent substrate and a phase shifter film which is provided on this transparent substrate and which has a predetermined exposure pattern and in that said
- 5 phase shifter film is a film formed by using a reactive long throw sputtering device.

62. The semiconductor device according to Claim 61, wherein said semiconductor device is a DRAM, an SRAM, a flash memory, an ASIC, a micro computer GaAs or a liquid crystal display.

63. A defect inspection method of a phase shift mask providing a transparent substrate and a phase shifter film which is provided on this transparent substrate and which has a predetermined exposure pattern, wherein said phase shifter film is a film formed by using a reactive long
5 throw sputtering device and, in the case that residue defects (black defects) or pinhole defects (white defects) occur in said phase shifter film, characterized in that a defect inspection is carried out on said phase shifter film through a chip comparison system by using light from a light source of a mercury lamp or a laser.

64. A defect correction method of a phase shift mask providing a transparent substrate and a phase shifter film which is provided on this transparent substrate and which has a predetermined exposure pattern, wherein said phase shifter film is a film formed by using a reactive long
5 throw sputtering device and, in the case that residue defects (black defects) occur in said phase shifter film, characterized in that the residue defects are corrected by carrying out a spatter etching on said residue defects (black defects) of the phase shifter film by means of a YAG laser or an FIB.

65. A defect correction method of a phase shift mask providing a transparent substrate and a phase shifter film which is provided on this transparent substrate and which has a predetermined exposure pattern, wherein said phase shifter film is a film formed by using a reactive long
5 throw sputtering device and, in the case that pinhole defects (white defects) occur in said phase shifter film, characterized in that a filling in correction of the pinhole defects is carried out on said pinhole defects (white defects) caused in the phase shifter film through deposition of a carbon based film by means of an FIB assisted deposition method.